CLAIMS

1. A method for producing a carbonic ester, comprising the steps of:

(1) performing a reaction between a first organometal compound mixture and carbon dioxide, said first organometal compound mixture comprising a mixture of a reactive organometal compound having in its molecule at least two metal-oxygen-carbon linkages and an unregenerable unreactive compound which is derived from said reactive organometal compound and which has in its molecule at least three metal-carbon linkages,

to thereby obtain a reaction mixture containing a carbonic ester formed by the reaction, said unregenerable unreactive compound, and a regenerable metamorphic organometal compound derived from said reactive organometal compound,

(2) separating said reaction mixture into a first portion containing said carbonic ester and said unregenerable unreactive compound, and a second portion containing said regenerable metamorphic organometal compound, and

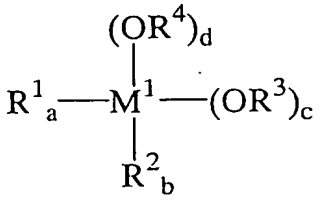
(3) reacting said second portion of said reaction mixture with a first alcohol to form a second organometal compound mixture and water and removing said water

from said second organometal compound mixture, said second organometal compound mixture comprising a mixture of a reactive organometal compound having in its molecule at least two metal-oxygen-carbon linkages and an unregenerable unreactive compound which is derived from said reactive organometal compound and which has in its molecule at least three metal-carbon linkages.

2. The method according to claim 1, which further comprises, after step (3), a step (4) in which said second organometal compound mixture obtained in step (3) is recovered and recycled to step (1).

3. The method according to claim 1 or 2, wherein said reactive organometal compound used in step (1) comprises at least one compound selected from the group consisting of:

an organometal compound represented by the formula (1):



(1)

wherein:

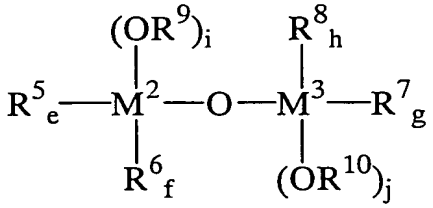
M^1 represents a metal atom selected from the group consisting of elements belonging to Groups 4 and 14 of the Periodic Table, exclusive of silicon;

each of R^1 and R^2 independently represents a straight chain or branched C_1-C_{12} alkyl group, a C_5-C_{12} cycloalkyl group, a straight chain or branched C_2-C_{12} alkenyl group, a C_7-C_{20} aralkyl group comprised of unsubstituted or substituted C_6-C_{19} aryl and alkyl selected from the group consisting of straight chain or branched C_1-C_{14} alkyl and C_5-C_{14} cycloalkyl, or an unsubstituted or substituted C_6-C_{20} aryl group;

each of R^3 and R^4 independently represents a straight chain or branched C_1-C_{12} alkyl group, a C_5-C_{12} cycloalkyl group, a straight chain or branched C_2-C_{12} alkenyl group, or a C_7-C_{20} aralkyl group comprised of unsubstituted or substituted C_6-C_{19} aryl and alkyl selected from the group consisting of straight chain or branched C_1-C_{14} alkyl and C_5-C_{14} cycloalkyl; and

each of a and b is an integer of from 0 to 2, a + b = 0 to 2, each of c and d is an integer of from 0 to 4, and a + b + c + d = 4; and

an organometal compound represented by the formula (2):



(2)

wherein:

each of M^2 and M^3 independently represents a metal atom selected from the group consisting of elements belonging to Groups 4 and 14 of the Periodic Table, exclusive of silicon;

each of R^5, R^6, R^7 and R^8 independently represents a straight chain or branched C_1-C_{12} alkyl group, a C_5-C_{12} cycloalkyl group, a straight chain or branched C_2-C_{12} alkenyl group, a C_7-C_{20} aralkyl group comprised of unsubstituted or substituted C_6-C_{19} aryl and alkyl selected from the group consisting of straight chain or branched C_1-C_{14} alkyl and C_5-C_{14} cycloalkyl, or an unsubstituted or substituted C_6-C_{20} aryl group;

each of R^9 and R^{10} independently represents a straight chain or branched C_1-C_{12} alkyl group, a C_5-C_{12} cycloalkyl group, a straight chain or

branched C_2-C_{12} alkenyl group, or a C_7-C_{20} aralkyl group comprised of unsubstituted or substituted C_6-C_{19} aryl and alkyl selected from the group consisting of straight chain or branched C_1-C_{14} alkyl and C_5-C_{14} cycloalkyl; and

each of e, f, g and h is an integer of from 0 to 2, e + f = 0 to 2, g + h = 0 to 2, each of i and j is an integer of from 1 to 3, e + f + i = 3, and g + h + j = 3.

4. The method according to claim 3, wherein each of R^3 and R^4 in formula (1) and R^9 and R^{10} in formula (2) independently represents an n-butyl group, an isobutyl group, a straight chain or branched C_5-C_{12} alkyl group, or a straight chain or branched C_4-C_{12} alkenyl group.

5. The method according to claim 3, wherein each of M^1 in formula (1) and M^2 and M^3 in formula (2) represents a tin atom.

6. The method according to claim 3, wherein said reactive organometal compound used in step (1) is produced from an organotin oxide and an alcohol.

7. The method according to claim 1 or 2, wherein, in

step (1), said reactive organometal compound is used in at least one form selected from the group consisting of a monomeric form, an oligomeric form, a polymeric form and an associated form.

8. The method according to claim 1 or 2, wherein, in step (1), said reactive organometal compound is used in an amount which is 1/50 to 1 time the stoichiometric amount relative to the amount of said carbon dioxide.

9. The method according to claim 1 or 2, wherein said reaction in step (1) is performed at 20 °C or higher.

10. The method according to claim 1 or 2, wherein said reaction in step (1) is performed in the presence of a second alcohol which is the same as or different from said first alcohol used in step (3).

11. The method according to claim 1 or 2, wherein, in step (2), said separation of said reaction mixture into said first portion and said second portion is performed by at least one separation method selected from the group consisting of distillation, extraction and filtration.

12. The method according to claim 1 or 2, wherein, in step (2), said separation of said reaction mixture into said first portion and said second portion is performed in the presence of an alcohol which is the same as or different from said first alcohol used in step (3).

13. The method according to claim 1 or 2, wherein said first alcohol used in step (3) is at least one alcohol selected from the group consisting of an alkyl alcohol having a straight chain or branched C_1-C_{12} alkyl group, a cycloalkyl alcohol having a C_5-C_{12} cycloalkyl group, an alkenyl alcohol having a straight chain or branched C_2-C_{12} alkenyl group, and an aralkyl alcohol having a C_7-C_{20} aralkyl group comprised of unsubstituted or substituted C_6-C_{19} aryl and alkyl selected from the group consisting of straight chain or branched C_1-C_{14} alkyl and C_5-C_{14} cycloalkyl.

14. The method according to claim 13, wherein said first alcohol has a boiling point which is higher than the boiling point of water, as measured under atmospheric pressure.

15. The method according to claim 14, wherein said first alcohol is at least one alcohol selected from the

group consisting of 1-butanol, 2-methyl-1-propanol, an alkyl alcohol having a straight chain or branched C_5-C_{12} alkyl group, an alkenyl alcohol having a straight chain or branched C_4-C_{12} alkenyl group, a cycloalkyl alcohol having a C_5-C_{12} cycloalkyl group, and an aralkyl alcohol having a C_7-C_{20} aralkyl group comprised of unsubstituted or substituted C_6-C_{19} aryl and alkyl selected from the group consisting of straight chain or branched C_1-C_{14} alkyl and C_5-C_{14} cycloalkyl.

16. The method according to claim 1 or 2, wherein said removal of said water in step (3) is performed by membrane separation.

17. The method according to claim 16, wherein said membrane separation is pervaporation.

18. The method according to claim 1 or 2, wherein said removal of said water in step (3) is performed by distillation.